TITLE OF THE INVENTION

NETWORK RELAYING DEVICE AND NETWORK RELAYING METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the

benefit of priority from the prior Japanese Patent

Application No. 2002-287117, filed September 30, 2002,

the entire contents of which are incorporated herein by

reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a network

relaying device for performing the relaying operation

with a plurality of wire networks, and in particular to

a network relaying device and a network relaying method

for achieving stable communication by optimizing the

size of transferred packets.

2. Description of the Related Art

With the recent development and extension of

the use of digital devices, demand has increased for

a network communication device for communication

between these digital devices. As such a conventional

data transfer technique (see the patent reference 1,

for example), a packet coupling method for a network

relaying device has been disclosed. In this

conventional technique, the maximum transfer unit (MTU)

of a transmission path is taken into consideration, and

the transfer rate is increased by coupling the packets

to the magnitude of the MTU and thus increasing the packet size. This data transfer technique is aimed at improving the communication efficiency by increasing the packet size for the relaying technique of a wire

5   network.

On the other hand, the fact that the packets to be transferred are larger than the maximum transferable size sometime makes the transfer impossible. Specifically, in the asynchronous packet transmission

10   and receiving between the devices on the same network, the packets transmitted from a transmitting-side device are written directly in the receiving buffer making up a receiving-side device. The upper limit of the packet size that can be transmitted at a time, therefore,

15   depends on the size of the receiving buffer constituting a receiving-side device. For transmitting the packets larger than the receiving buffer size of the receiving-side devices, therefore, the transmitting-side devices are required to divide a

20   desired transmission packet into packets each not larger than the receiving buffer size of the receiving-side devices, and transmit the divided packets in a plurality of sessions. For this reason, the transmitting-side devices are required to investigate

25   the maximum receivable size of the receiving-side devices in advance.

This requirement is highly crucial in the case

where a plurality of wire networks are relayed (by
radio or wire) through a network relaying device rather
than in the case where communication is carried out
with a single wire network. Even in the case where the
packet size is optimized according to the wire network
communication standards, the communication between the
devices on a plurality of networks cannot be carried
out with the optimum packet size unless the maximum
transferable size is taken into consideration based on
the buffer size, etc. of the network relaying device.
Specifically, the conventional device poses the problem
that the radio communication by the network relaying
device and the long-distance network relaying device
are liable to have an insufficient transfer capacity.
Also, the packet size is determined without considering
the maximum receivable size of the network relaying
device with a somewhat small buffer size. As a result,
the packet size is not optimized and the stable
communication is impossible.

More specifically, in the conventional network
relaying device, assume that different wire networks
are relayed by a network relaying device and
communication is carried out between electronic devices
on each network according to the wire network
communication standards. The packet size is determined
taking the buffer size, etc. of each electronic device
into consideration based on the functions under the

communication standards without considering the maximum
receivable size of the network relaying device which is
liable to have an insufficient communication speed and
buffer size. As a result, the buffer size of the
5   network relaying device is liable to become
insufficient as compared with the packets, thereby
leading to the problem that the packet transfer
sometimes becomes impossible.

BRIEF SUMMARY OF THE INVENTION

10   According to one embodiment of the invention,
there is provided a network relaying device comprises
a determining unit which detects size information for
data transfer of devices including a transmitting-side
device arranged on network, a transmitting-side network
15   relaying device connected to the transmitting-side
device, a receiving-side network relaying device for
performing the relaying operation with the
transmitting-side network relaying device, and a
receiving-side device connected to the receiving-side
20   network relaying device and arranged on the receiving-
side networks, and which determines the minimum one of
the size information as a maximum transferable size;
and an updating unit which updates a maximum
transferable size information of the transmitting-side
25   device based on the maximum transferable size
determined by the determining unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing an example of a configuration of a network relaying device according to the invention;

FIG. 2 is a device diagram showing an example of a network relaying system using network relaying devices according to the invention;

FIG. 3 is a diagram for explaining an example of the information stored in a receiving buffer size storage unit of each network relaying device according to the invention;

FIG. 4 is a diagram for explaining an example of the information managed by a maximum transferable size storage unit of each network relaying device according to the invention;

FIG. 5 is a flowchart showing the operation for determining the maximum transferable data size using the receiving buffer size in a network relaying device according to a first embodiment of the invention;

FIG. 6 is a flowchart showing the operation for determining the maximum transferable data size using the maximum command size in a network relaying device according to a second embodiment of the invention; and

FIG. 7 is a flowchart showing the operation for determining the maximum transferable data size using the receiving buffer size in a network relaying device according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

An example of a network relaying device and a network relaying method according to the invention will be explained below with reference to the accompanying drawings.

[First embodiment]

According to a first embodiment of the invention, there is provided a network relaying device for achieving stable communication, wherein the buffer size of each network relaying device as well as the buffer size of electronic devices on a wire network is detected, and the minimum one of the buffer sizes thus detected is determined as a maximum transferable size, whereby the maximum transferable size information of the transmitting-side device is updated. Especially, the packet size is determined taking also the buffer size of each network relaying device into consideration. FIG. 1 is a block diagram showing an example of a configuration of a network relaying device according to the invention, FIG. 2 is a system diagram showing an example of a network relaying system using the network relaying devices according to this invention, FIG. 3 is a diagram for explaining an example of the information stored in a receiving buffer size storage unit, FIG. 4 is a diagram for explaining an example of the information managed by a maximum transferable size storage unit 27, and FIG. 5 is

a flowchart showing the operation of determining the maximum transferable data size using the receiving buffer size in a network relaying device according to the invention.

5   [System example]

In an example of a network relaying system using network relaying devices according to this invention, as shown in FIG. 2, AV devices (digital television DTV 11, video tape recorder: first VTR 13, video tape

10   recorder; second VTR 12) and two network relaying devices (first network relaying device 10, second network relaying device 10') according to the invention are connected to each other, respectively, on a plurality of independent wire networks N, N'.

15   The first network N is configured of the DTV 11, the second VTR 12 and the first network relaying device 10. These devices are connected to each other by a digital interface IEEE 1394. Nevertheless, another digital interface such as USB2.0 or the like

20   can be used with the same effect. Similarly, the second network N' is configured of the first VTR 13 and the second network relaying device 10', and these devices are interconnected by IEEE 1394. The first network relaying device 10 and the second network

25   relaying device 10' carry out radio communication using a protocol such as IEEE 802.11, for example. Nevertheless, the invention is applicable also to

a wire network relaying device using a protocol such as
IEEE 1394b.

The AV devices 11, 12, 13 and the network relaying
devices 10, 10' shown in FIG. 2 each have mounted

5   thereon a receiving buffer for receiving data packets.
By way of explanation, assume that the size of the
receiving buffer of each device is 256 bytes for the
DTV 11, 128 bytes for the first VTR 13, 128 bytes for
the second VTR 12, 64 bytes for the first network

10 relaying device 10, and 32 bytes for the second network
relaying device 10'.
[Example of network relaying device]

An example of a configuration of a network
relaying device according to the invention will be

15 explained with reference to FIG. 1. A network relaying
device 10 comprises a 1394 physical layer and a 1394
link layer 22 connected to a 1394 connector 21, a
receiving data buffer 23 connected to the 1394 physical
layer and the 1394 link layer 22, and a transaction

20 content determining unit 24 connected to the receiving
data buffer 23 for controlling and coordinating the
whole operation. The network relaying device 10
further comprises devices connected to the transaction
content determining unit 24, including a data content

25 updating unit 25, a memory space 26 capable of being
read and written by other devices, a maximum
transferable size storage unit 27, a maximum

transferable size determining unit 29 and a
transmission data dividing unit 30. The network
relaying device 10 also comprises a receiving buffer
size acquisition unit 28 connected to the 1394 physical
layer and the 1394 link layer 22 and the receiving data
buffer 23. The receiving buffer size acquisition
unit 28 is further connected to the receiving buffer
size storage unit 33 and the data transmitting unit 32.
Further, the network relaying device 10 comprises
a data receiving unit 31 connected to the receiving
data buffer 23, etc.
[Operation flowchart]

   The process for determining and updating the
maximum transferable size using the receiving buffer of
the network relaying device 10 shown in FIG. 1 will be
explained in detail with reference to the flowchart of
FIG. 5.

   First, in step S11 of the flowchart shown in
FIG. 5, the receiving buffer size acquisition unit 28
of the network relaying device 10 investigates the
maximum data size each device can receive in one
asynchronous transaction as a part of the
initialization process executed after switching on
power or resetting the bus with a change in the
configuration of the devices connected to the network
(S11). The investigation of the devices in the network
associated with the network relaying device 10 is

conducted by transmitting an investigation request
packet to the particular devices through the 1394
units 21, 22 (1394 link layer, 1394 physical layer,
1394 connector) and analyzing by fetching from the
5   receiving data buffer 23 the response packets returned
from the devices. The receiving buffer information for
the devices in the network acquired by the analysis is
stored in the receiving buffer size storage unit
together with the receiving buffer information of the
10   network relaying device itself (S11).

    In the system of FIG. 2, for example, the first
network relaying device 10 investigates the DTV 11 and
the second VTR 12 of the first network N associated
therewith and has the acquired receiving data buffer
15   size information stored in the receiving buffer size
storage unit 33 together with the information on the
first network relaying device 10 itself.

    The investigation of the devices other than those
associated with the network N of the network relaying
20   device 10 is conducted by transmitting an investigation
request packet to the network associated with the
particular devices through the data transmitting
unit 32 and analyzing by fetching from the receiving
data buffer 23 the response packets returned by the
25   devices. The receiving buffer information of each
device of the other networks acquired by this analysis
are stored in the receiving buffer size storage

unit 33.

In FIG. 2, for example, the first network relaying device 10 investigates the second network relaying device 10' and the first VTR 13 of the second network N' through the second network relaying device 10', and has the acquired receiving data buffer size information stored in the receiving buffer size storage unit 33.

An example of the information stored in the receiving buffer size storage unit 33 upon completion of the process up to this stage is shown in FIG. 3. Each AV device connected to the network acquires the basic information such as the device type and the device name of the other devices as an initialization process after power is switched on or the bus resetting with a change in the configuration of the devices connected to the network. The basic information investigated includes the maximum data size that each device can receive in one asynchronous transaction.

In the transactions used for this investigation, the request packet for acquiring the information on the devices connected to other networks is transmitted through the network relaying devices 10, 10' to a receiving-side device involved.

Consider a case in which the DTV 11 shown in FIG. 2, for example, transmits an investigation request packet through the network device to the first VTR 13 in order to investigate the maximum data size the first

VTR 13 can receive in one asynchronous transaction.
The request packet transmitted by the DTV 11 is
received by the 1394 units 21, 22 (1394 connector, 1394
physical layer and 1394 link layer) of the first
network relaying device 10 and written in the receiving
data buffer 23.

Next, in step S12 of the flowchart shown in
FIG. 5, the transaction content determining unit 24
determines whether the request packet written in the
receiving data buffer 23 is aimed at investigating the
receiving buffer size of the devices associated with
the other networks or not. Various criteria are
conceivable for this determination. An example is
a method of determining whether the request packet is
a read request packet for the maximum receivable size
information of each device written in the memory space
capable of being read by other devices.

A device having the 1394 interface, for example,
has a memory space capable of being read and written by
other devices through the 1394 units connected at the
same time. This device has a readable area called the
configuration ROM including the description of various
basic information as a part thereof. This area
includes, at a specific address (0xFFFFF0000408), what
is called the max_rec field where a maximum data size
that can be received in one asynchronous transaction.
In the case where the request packet is aimed at

requesting the reading of this address, therefore, it
can be determined that the request packet is aimed at
investigating the receiving buffer size of the devices
associated with other networks.

In the case where the determination is negative,
the request packet is transferred directly to the
network relaying device of the network associated with
the receiving-side device designated by the header of
the request packet using the data transmitting unit 32.

In the case where the determination is
affirmative, on the other hand, the transaction content
determining unit 24 delivers the information on the
request packet transmitting-side device and the
receiving-side device designated by the header of the
request packet to the maximum transferable size
determining unit 29 and instructs the maximum
transferable size determining unit 29 to determine the
maximum transferable data size for the communication
path from the transmitting-side device to the
receiving-side device (S12).

Next, in step S13 of the flowchart shown in
FIG. 5, the maximum transferable size determining
unit 29 determines the maximum transferable data size
for the communication path from the transmitting-side
device designated by the transaction content
determining unit 24 to the receiving-side device based
on the information on the receiving buffer size of each

device managed by the receiving buffer size storage
unit 33.

The maximum transferable data size is determined
by a method in which the sizes of the receiving packets
5   held in the designated transmitting-side device 11, the
network relaying device 10 associated with the
transmitting-side device 11, the network relaying
device 10' associated with the designated receiving-
side device 13 and the receiving-side device 13 are
10   compared with each other, and the minimum size among
them is determined as a maximum transferable data
size (S13).

In the case where the transaction content
determining unit 24 issues an instruction to determine
15   the maximum transferable data size for the
communication path from the DTV 11 of the first network
N to the first VTR 13 of the second network N',
for example, the determining unit 29 determines the
maximum transferable data size as 32 bytes for the
20   communication path from the DTV 11 to the first VTR 13,
which is found to be the minimum value as the result of
comparison among the size of 256 bytes of the receiving
data buffer 23 of the DTV 11 constituting a designated
transmitting-side device, the size of 64 bytes of the
25   receiving data buffer 23 of the first network relaying
device 10 of the first network N associated with the
DTV 11, the size of 32 bytes of the receiving data

buffer 23 of the second network relaying device 10' of
the second network N' associated with the first VTR 13
constituting a designated receiving-side device and the
receiving data buffer size of 128 bytes of the first
5   VTR 13 making up a receiving-side device.

The value of the data size thus determined is
managed by being written in the maximum transferable
size storage unit 27 as a determination result.

Next, in step S14 of the flowchart shown in
10   FIG. 5, after an instruction is given to the maximum
transferable size determining unit 29 in step S12, the
transaction content determining unit 24 transfers,
using the data transmitting unit 32, the request packet
to the network relaying device 10' of the network
15   associated with the receiving-side device designated by
the header of the request packet. The network relaying
device 10' making up a receiving-side device that has
received the transferred request packet transfers the
same request packet to the receiving-side device
20   designated by the header of the request packet (S14).

In the example described above, the request packet
is transferred from the first network relaying device
10 to the first VTR 13 after being transferred to the
second network relaying device 10' making up a network
25   relaying device associated with the first VTR 13 which
is one of the receiving-side devices.

The request packet sent from the DTV 11 is

an investigation request packet to investigate the
maximum data size that the first VTR 13 can receive in
each asynchronous transaction. In step S15 of the
flowchart shown in FIG. 5, therefore, the size of
128 bytes of the receiving buffer mounted on the first
VTR 13 is returned to the DTV 11 of the requesting
first network N as a transaction response. This
response packet, similarly to the request packet, is
first received by the second network relaying device
10' of the second network N', and then transferred to
the first network relaying device 10 of the first
network N associated with the DTV 11 designated at the
receiving end (step S15).

Next, the process of step S16 will be explained
with reference to the flowchart of FIG. 5. The
response packet received through the data receiving
unit 31 is written in the receiving data buffer 23 by
the first network relaying device 10. The transaction
content determining unit 24 determines whether the
received response packet is in response to the request
packet that has been transferred in the process of
step S14.

In the case where it is determined that the
response packet is not such a response, the response
packet is transferred to the receiving-side device
(request packet transmitting-side device) designated by
the header of the response packet, using the 1394

units 21, 22.

In the case where it is determined that the response packet is such a response, on the other hand, the transaction content determining unit 24 acquires the maximum transferable size among the request packet transmitting-side devices and the response packet transmitting-side devices (request packet receiving-side devices) from the information managed by the maximum transferable size storage unit 27 (S16).

Next, in step S17 of the flowchart shown in FIG. 5, the transaction content determining unit 24 instructs the data updating unit 25 to update the size information contained in the response packet together with the size information acquired (S17).

In the example described above, the maximum transferable size (32 bytes) between the DTV 11 making up a request packet transmitting-side device and the first VTR 13 making up a response packet transmitting-side device is acquired from the information shown in FIG. 4 managed by the maximum transferable size storage unit 27, and the data updating unit 25 is instructed to update the size information (128 bytes) contained in the response packet to 32 bytes.

The data updating unit 25 thus updates the information on the receiving data buffer size contained in the response packet to the value designated by the transaction content determining unit 24, and returns

the updated value to the transaction content
determining unit 24.

Next, in step S18 of the flowchart shown in
FIG. 5, the response packet containing the information
on the receiving data buffer size updated by the data
updating unit 25 is transferred to the DTV 11
designated by the receiving-side device in the
header of the response packet, through the 1394
units 21, 22 (S18).

Finally, in step S19 of the flowchart shown in
FIG. 5, the DTV 11 that has received the response
packet recognizes from the contents of the response
packet that the maximum data size that the first VTR 13
of the second network N' can receive in one
asynchronous transaction is 32 bytes.

As a result, a data packet larger than 32 bytes,
which the DTV 11 may intend to transmit to the first
VTR 13, is divided beforehand into a plurality of data
packets each not more than 32 bytes in size (S19).

Assume, for example, that the DTV 11 produces and
manages the tuning information of 256 bytes in size.
Upon receipt of a request from the first VTR 13 to read
this tuning information, the DTV 11 divides the tuning
information into eight packets of 32 bytes and
transmits them to the first VTR 13 in eight sessions.
As a result, communication can be conducted with
optimum packet size taking the buffer size of the

network relaying device into consideration, and a network relaying device capable of achieving stable communication can be provided. Thus, stable communication is established with a protocol of optimum size between the transmitting-side electronic devices and the receiving-side electronic devices on the wire network by executing the process of the invention only for the network relaying device without any specific change in the protocol.

With the processing described above, the network relaying device according to the invention can establish stable data communication with each packet always divided into packets of a transferable size for the communication path between the devices on the wire network.

[Second embodiment]

According to the second embodiment, there is provided a network relaying device in which the buffer size is not detected unlike in the first embodiment, but the maximum command size, i.e. the usable command length is detected not only for the electronic devices on the wire network but also for the network relaying device, and among these maximum command sizes, the minimum one is determined as a maximum transferable packet size thereby to update the maximum transferable size information of the transmitting-side devices.

FIG. 6 is a flowchart showing the operation of

determining the maximum transferable data size using

the maximum command size for the network relaying

device according to the second embodiment of the

invention.

5   With reference to the drawings, the second

embodiment of the invention will be explained below.

The second embodiment also comprises AV devices and two

network relaying devices connected in the network

configuration shown in FIG. 2. Each network relaying

10   device has a configuration as shown in FIG. 1, for

example.

         With reference to FIG. 1, each step of the process

will be explained.

         First, in step S21 in the flowchart of FIG. 6, the

15   network relaying device 10 according to this invention

so operates that a receiving buffer size acquisition

unit 28 investigates the maximum size usable by each

device for transmission and receiving of a command

defined for each of various protocols as a part of the

20   initialization process executed after power is switched

on or after the bus is reset with a change in

the configuration of the devices connected to the

network (S21).

         The investigation of the devices in the network

25   associated with the network relaying device 10 is

conducted by transmitting an investigation request

packet through the 1394 units 21, 22 (1394 link layer,

1394 physical layer, 1394 connector) and analyzing by fetching the response packets returned by each device, from the receiving data buffer 23. The maximum command size information of each device in the network acquired by this analysis is stored in the receiving buffer size storage unit 33 together with the maximum command size information of the network device itself (S21).

In FIG. 2, for example, the first network relaying unit 10 investigates the DTV 11 and the second VTR 12 of the first network N of itself and stores the acquired maximum command size information in the receiving buffer size storage unit 33 together with the information on the first network relaying unit 10.

The investigation of the devices belonging to other than the network associated with the network relaying device 10 is conducted by transmitting an investigation request packet through the data transmitting unit 32 to the network associated with the devices to be investigated and analyzing by fetching the response packets returned by each device, from the receiving data buffer 23. The maximum command size information of each device of other network acquired by the analysis are stored in the receiving buffer size storage unit 33 (S21).

In FIG. 2, for example, the first network relaying device 10 investigates the first VTR 13 and the second network relaying device 10' of the second network N'

through the second network relaying device 10' and has
the acquired maximum command size information stored in
the receiving buffer size storage unit 33. An example
of the information stored in the receiving buffer size

5   storage unit 33 after completing the process up to this
stage is shown in FIG. 3.

Each AV device connected to the network acquires
the basic information such as device type and device
name from other devices as an initialization process

10   executed after power is switched on or the bus is reset
with the change in the configuration of the devices
connected to the network. The basic information
include the result of the investigation of the maximum
size usable by each device for transmission and

15   receiving of the command defined for various protocols.
Of the transactions used for this investigation, the
request packet for acquiring the information on the
devices connected to other networks is transmitted to
the devices involved through the network relaying

20   device.

For example, consider a case in which the DTV 11
shown in FIG. 2 transmits an investigation request
packet to the first VTR 13 through the network relaying
device to investigate the maximum size usable by the

25   first VTR 13 for transmission and receiving of the
command defined for various protocols.

The request packet transmitted by the DTV 11 is

received by the 1394 units 21, 22 (1394 connector, 1394 physical layer, 1394 link layer) of the first network relaying device 10 and written in the receiving data buffer 23.

Next, in step S22 of the flowchart shown in FIG. 6, the transaction determining unit 24 determines whether the request packet written in the receiving data buffer 23 is a request packet for investigating the maximum command size of the devices associated with other networks. One of various criteria conceivable for this purpose is to use a method for determining whether a command request packet prepared for investigation of the maximum size usable for transmission and receiving of a command is included in a command set defined for various protocols.

A device having the 1394 interface mounted thereon, for example, has a memory space capable of reading and writing through the 1394 unit from other devices connected at the same time, and a part of the memory space makes up a writable area called an FCP command register to receive a control command called the AV/C command. Various devices can be controlled by writing the data having the contents defined by the AV/C command in this specified address (0xFFFFF0000B00 address). The AV/C command defines various commands corresponding to the contents of the control operation including a command prepared for investigation of the

maximum size usable for transmission and receiving of

a command. In the case where the request packet is

a write request to the above-mentioned address and the

contents of the data thereof correspond to a command

5 prepared for investigation of the maximum size usable

for transmission and receiving of the command,

therefore, it can be determined that the request packet

is the one for investigating the maximum command size

of a device associated with other networks.

10 In the case where the result of determination

shows that the request packet is not for investigating

the maximum command size of the device associated with

other networks, the particular request packet is

transferred directly to the network relaying device of

15 the network associated with the receiving-side device

designated by the header of the request packet using

the data transmitting unit 32.

In the case where the result of determination

shows that the request packet is aimed at investigating

20 the maximum command size of the devices associated with

other networks, on the other hand, the transaction

content determining unit 24 delivers the information on

the request packet transmitting-side device and the

receiving-side device designated by the header of the

25 request packet to the maximum transferable size

determining unit 29 and thus instructs the maximum

transferable size determining unit 29 to determine the

maximum transferable data size for the communication path from the transmitting-side device to the receiving-side device (S22).

Next, in step S23 of the flowchart shown in FIG. 6, the maximum transferable size determining unit 29 determines the maximum transferable data size for the communication path from the transmitting-side device designated by the transaction content determining unit 24 to the receiving-side device based on the information on the maximum command size of the device on each bus managed in the receiving buffer size storage unit 33 (S23).

The maximum transferable data size is determined in such a manner that the maximum command sizes of a designated transmitting-side device, a relaying device of the network associated with the transmitting-side device, a relaying device of a network associated with a designated receiving-side device and the receiving-side device are compared with each other, and the minimum one of them is determined as a maximum transferable data size.

Assume, for example, that the transaction content determining unit 24 gives an instruction to determine the maximum transferable data size for the communication path from the DTV 11 of the first network N to the first VTR 13 of the second network N'.
The determining unit 29 compares the maximum command

size of 256 bytes of the DTV 11 making up a designated transmitting-side device, the maximum command size of 64 bytes of the first network relaying device 10 of the first network N associated with the DTV 11, the maximum command size of 32 bytes of the second network relaying device 10' of the second network N' associated with the first VTR 13 making up a designated receiving-side device and the maximum command size of 128 bytes of the first VTR 13 making up the receiving-side device with each other. As a result, the minimum size of 32 bytes is determined as a maximum transferable data size for the communication path from the DTV 11 to the first VTR 13.

The value of the data size thus determined is written in and managed by the maximum transferable size storage unit 27 as a determination result. An example of the information managed by the maximum transferable size storage unit 27 is shown in FIG. 4.

Next, in step 24 of the flowchart shown in FIG. 6, the transaction content determining unit 24, after giving an instruction to the maximum transferable size determining unit 29 to determine the maximum transferable data size in step 22, transfers a request packet to the network relaying device 10' of the network associated with the receiving-side device designated by the header of the request packet using the data transmitting unit 32. The network relaying

device 10' at the receiving-side device that has

received the request packet thus transferred transfers

the particular request packet to the receiving-side

device designated by the header of the request

5   packet (S24).

In the example described above, the request packet

is transferred to the first VTR 13, after being

transferred to the second network relaying device 10'

of the network associated with the first VTR 13 at the

10   receiving-side device from the first network relaying

device 10.

Next, in step 25 of the flowchart shown in FIG. 6,

the request packet sent from the DTV 11 has proved to

be a command request packet prepared to investigate

15   the maximum size usable by the first VTR 13 for

transmission and receiving of a command. Thus, the

maximum size of 128 bytes that can be handled by the

first VTR 13 for transmission and receiving of

a command is returned by the first VTR 13 as

20   a transaction response to the requesting DTV 11 of

the first network N. This response packet, like the

request packet, is first received by the second network

relaying device 10' of the second network N', and then

transferred to the first network relaying device 10 of

25   the first network N associated with the DTV 11

designated at the receiving end (S25).

Next, the process of step 26 in the flowchart of

FIG. 6 will be explained. The response packet received through the data receiving unit 31 is written in the receiving data buffer 23 by the first network relaying device 10. The transaction content determining unit 24 determines whether the response packet received is the one returned to the request packet transferred by the process of step 24.

In the case where the determination shows that the response packet is not the one returned to the request packet, the particular response packet is transferred to the receiving-side device (the transmitting-side device for the request packet) designated by the header of the response packet using the 1394 units 21, 22.

In the case where the determination shows that the response packet is the one returned to the request packet, on the other hand, the transaction content determining unit 24 acquires the maximum transferable size between the transmitting-side device for the request packet and the transmitting-side device for the response packet (the receiving-side device for the request packet) from the information managed by the maximum transferable size storage unit 27 (S26).

Next, the process of step 27 in the flowchart of FIG. 6 will be explained. The transaction content determining unit 24 instructs the data updating unit 25 to update the size information contained in the response packet together with the size information

acquired. In the example described above, the maximum
transferable size (32 bytes) between the DTV 11 making
up a transmitting-side device for the request packet
and the first VTR 13 making up a transmitting-side
device for the response packet is acquired from the
information (FIG. 4) managed by the maximum
transferable size storage unit 27, and instructs the
data updating unit 25 to update the size information
(128 bytes) contained in the response packet to
32 bytes (S27).

In response, the data updating unit 25 updates the
information on the maximum command size contained in
the response packet to the value designated by the
transaction content determining unit 24 and returns the
updated information to the transaction content
determining unit 24 (S27).

Next, in step 28 of the flowchart shown in FIG. 6,
the response packet, with the information on the
maximum command size thereof updated by the data
updating unit 25, is transferred to the DTV 11 making
up a receiving-side device designated by the header of
the response packet through the 1394 units 21, 22
(S28).

Finally, in step 29 of the flowchart shown in
FIG. 6, the DTV 11 that has received the response
packet recognizes, from the contents of the response
packet, that the maximum data size that can be handled

by the first VTR 13 of the second network N' for
transmission and receiving of the command is 32 bytes.
As a result, in the case where a command packet
exceeding 32 bytes in size is transmitted to the first
VTR 13 by the DTV 11, the particular command packet is
divided into a plurality of packets each not more than
32 bytes in size.

For some devices on the network, the maximum size
usable for transmission and receiving of a command is
set to a value smaller than the size of the receiving
buffer actually mounted. Therefore, the maximum
transferable size can be more effectively determined in
terms of the maximum command size as in the second
embodiment than in terms of the receiving buffer size
as in the first embodiment.

As described in detail above, in the second
embodiment as in the first embodiment, a packet is
always divided into a plurality of packets not larger
than the transferable size for the communication path
between the devices on the wire network. Thus, stable
data communication can be achieved.

[Third embodiment]

According to a third embodiment, unlike in the
first and second embodiments, there is provided a
network relaying device in which the maximum
transferable size information of the transmitting-side
device is not updated in accordance with the maximum

transferable size determined, but the packet received
by a network relaying device is divided by itself in
accordance with the maximum transferable size. FIG. 7
is a flowchart showing the operation for determining
the maximum transferable data size using the receiving
buffer size of the network relaying device according to
the third embodiment of the invention.

With reference to the drawings, the third
embodiment of the invention will be explained. Also in
the third embodiment, AV devices and two network
relaying devices according to the invention are
connected in the network configuration shown in FIG. 2.
Each network relaying device has a configuration as
shown in FIG. 1, for example.

Also in the network relaying device according to
the third embodiment, the processing operation of steps
S11 to S19 or steps S21 to S29 in the flowchart of
FIG. 5 or 6 is performed similarly.

In step S18 or S28, the information on the maximum
transferable data size for each communication path are
stored and managed in the maximum transferable size
storage unit 27. Under this condition, as shown in
step S19 or S29, in the case where a transmitting-side
device transmits or receives the data to and from
another network, such data are expected to be
transmitted in a plurality of sessions by dividing each
packet into packets each not more than the maximum

transferable data size. The third embodiment, however, deals with the process executed in the case where the network relaying device 10 has received packets larger than the maximum data size.

5   Specifically, in the flowchart of FIG. 7, assume that in response to a transaction request transmitted from the first VTR 13 shown in FIG. 2, the DTV 11 shown in FIG. 2 transmits a transaction response packet of 64 bytes in size to the first VTR 13. The response

10   packet transmitted by the DTV 11 is received by the 1394 units 21, 22 (1394 connector, 1394 physical layer, 1394 link layer) of the first network relaying device 10 (S31), and then written in the receiving data buffer 23 (S32).

15   The response packet written in the receiving data buffer 23 is checked for the data size by the transaction content determining unit 24 (S33). The transaction content determining unit 24 acquires the maximum transferable size between the DTV 11 making up

20   a transmitting-side device designated by the header of the response packet and the first VTR 13 designated as a receiving-side device, and checks to see whether the data size of the response packet has not exceeded the maximum size (S34). In the case where the data size

25   does not exceed the maximum size, the packet is transferred to a destination device without executing any process (S37).

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In this case, the data size of the response packet
is 64 bytes. Since the acquired maximum size is
32 bytes, however, the transaction content determining
unit 24 instructs the transmission data dividing

5   unit 30 to divide the response packet into packets each
not more than 32 bytes (S35). In compliance with the
instruction of the transaction content determining
unit 24, the transmission data dividing unit 30 divides
the response packet into two packets of 32 bytes and

10   returns them to the transaction content determining
unit 24. The transaction content determining unit 24
transmits the divided packets of 32 bytes to the first
VTR 13 of the second network N' in two sessions using
the data transmitting unit 32 (S36).

15   As the result of the process described above, even
in the case where a request to transmit a packet larger
than the maximum transferable size is received due to
such causes as a defect of the dividing process of the
transmitting-side device, stable communication can be

20   established between devices by dividing the packet into
packets not larger than the maximum transferable size.

The dividing process executed in the third
embodiment is not necessarily accompanied by the
transfer of the update information of the maximum

25   transferable size to the transmitting-side device
unlike in the first and second embodiments.
Specifically, even in the case where the process of

dividing all the packets is executed by the network

relaying device according to the invention, a high-

speed communication is made possible with the optimum

packet size in similar fashion.

5   The network relaying device is an independent

entity in each of the embodiments described above.

Even in the case where the network relaying device is

incorporated in the AV device, however, the present

invention exhibits exactly the same effects of

10   operation for the same reason as described above.

Although the IEEE 1394 is explained as an example

of the standards for an interface in each of the

embodiments described above, the invention is

applicable also to other digital interfaces such as USB

15   2.0 with the same effect.

Further, the invention is applicable regardless of

whether the network relaying device is aimed at radio

communication or for wire communication.

The various embodiments of the invention described

20   above can be achieved by those skilled in the art.

Further, it is easy for those skilled in the art not

only to conceive various modifications of these

embodiments, but also to apply the invention to various

embodiments without any inventive ability. This

25   invention, therefore, is applicable to a wide range not

in conflict with the principle and the novel features

disclosed, and not limited to the embodiments described

above.

It will thus be understood from the detailed description above that according to this invention, the buffer sizes of not only the transmitting- and receiving-side devices but also the network relaying device are taken into consideration, so that the minimum value of these buffer sizes is determined as a maximum transferable size. In this way, the packet size reflecting a value constituting a bottleneck to communication can be determined, thereby making it possible to provide a network relaying device and a network relaying method for achieving stable communication.